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REPORT FOR CONSULTATION ON THE HAWAIIAN ISLANDS INTRASTATE AIR QUALITY CONTROL REGION (HAWAII)

Public Health Service
Washington, D. C.

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REPORT FOR CONSULTATION
ON THE
HAWAIIAN ISLANDS
INTRASTATE AIR QUALITY CONTROL REGION
(HAWAII)

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

PREFACE

The Clean Air Act, as amended, directs the Secretary of Health, Education, and Welfare to designate "air quality control regions" to provide a basis for the adoption of regional ambient air quality standards and the implementation of those standards. The Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities. This report is intended to provide background information for a formal consultation. It proposes boundaries for the Hawaiian Islands Intrastate Air Quality Control Region and discusses the factors which are the basis of the boundary proposal.

The Region* boundaries proposed in this report reflect consideration of available and pertinent information. However, the proposed boundaries remain subject to revisions suggested during the consultation with State and local authorities. Formal designation of the Region will be made only after a careful review of all opinions and suggestions submitted during the consultation process.

The National Air Pollution Control Administration appreciates assistance received from the several agencies of the State of Hawaii including the Air Sanitation Branch of the State Department of Health, and the State Department of Planning and Economic Development.

* For the purposes of this report, the word "region", when capitalized, will refer to the proposed Hawaiian Islands Intrastate Air Quality Control Region.

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INTRODUCTION

THE REGIONAL APPROACH

Air pollution in the urban areas of the United States is a regional problem which frequently extends across State and local governmental boundaries. Since air pollution problens are rarely confined to any single municipality or county, successful control requires coordinated planning, standard setting, and enforcement by the several political jurisdictions which share a common problem. To date, State and local governments across the Nation have only begun to develop a regional approach to air pollution control.

The Clean Air Act, as amended, provides a regional approach which depends upon coordination and cooperation among all levels of government; municipal, county, State, and Federal. To set in motion the machinery for regional air pollution control, the Department of Health, Education, and Welfare designates air quality control regions, issues air quality criteria, and publishes reports on control techniques. The region designation identifies those State and local jurisdictions which will be involved in a regional air pollution control effort. The air quality criteria indicate the extent to which various concentrations of air pollutants are harmful to health and damaging to property. The reports on control techniques provide information on the costs and effectiveness of various techniques for controlling air pollutant emissions.

After the Department of Health, Education, and Welfare completes these initial steps, State governments adopt ambient air quality standards and develop plans for implementation of those standards for areas within air quality control regions. An air quality standard defines the desired limit on the concentration of a pollutant in the ambient air of a region. It represents the level of air quality which the regional control program will attempt to achieve. An implementation plan is a blueprint of the steps which will be taken to insure achievement of the air quality standards within a reasonable time. The Governors have 90 days either from the time that they are furnished the criteria and control technology reports or from the time that a region is designated by the Department of Health, Education, and Welfare---whichever occurs last---to submit letters indicating their intent to set standards. They have an additional 180 days to set the standards, and another 180 days to develop plans for implementing those standards. The procedure for setting standards includes a public hearing which allows residents of a region to express their views concerning desired standards.

The Department of Health, Education, and Welfare reviews air quality standards and implementation plans in order to ascertain their consistency with the provisions of the Clean Air Act.

When air quality standards and implementation plans are approved, States proceed to prevent and control air pollution in

accordance with those standards and plans. This system for establishing a regional approach to air pollution control is outlined in Figure 1.

DESIGNATION OF AIR QUALITY CONTROL REGIONS

Designation of an air quality control region is one of the first steps in the regional approach to air pollution control. Section 107 (a) (2) of the Clean Air Act, as amended, directs The Secretary, Department of Health, Education, and Welfare to make such designations. The portions of the section relevant to this discussion state:

> "...The Secretary, after consultation with appropriate State and local authorities shall...designate air quality control regions based on jurisdictional boundaries, urban industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may... revise the designation of such regions...The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."

Procedure For Designation of Regions

Figure 2 illustrates the procedures used by the National Air Pollution Control Administration (NAPCA) to designate air quality control regions.

After evaluating relevant technical and urban factors, the National Air Pollution Control Administration publishes a proposed delineation of the region boundaries. At the same time NAPCA sets a time and place for a consultation meeting and distributes to State

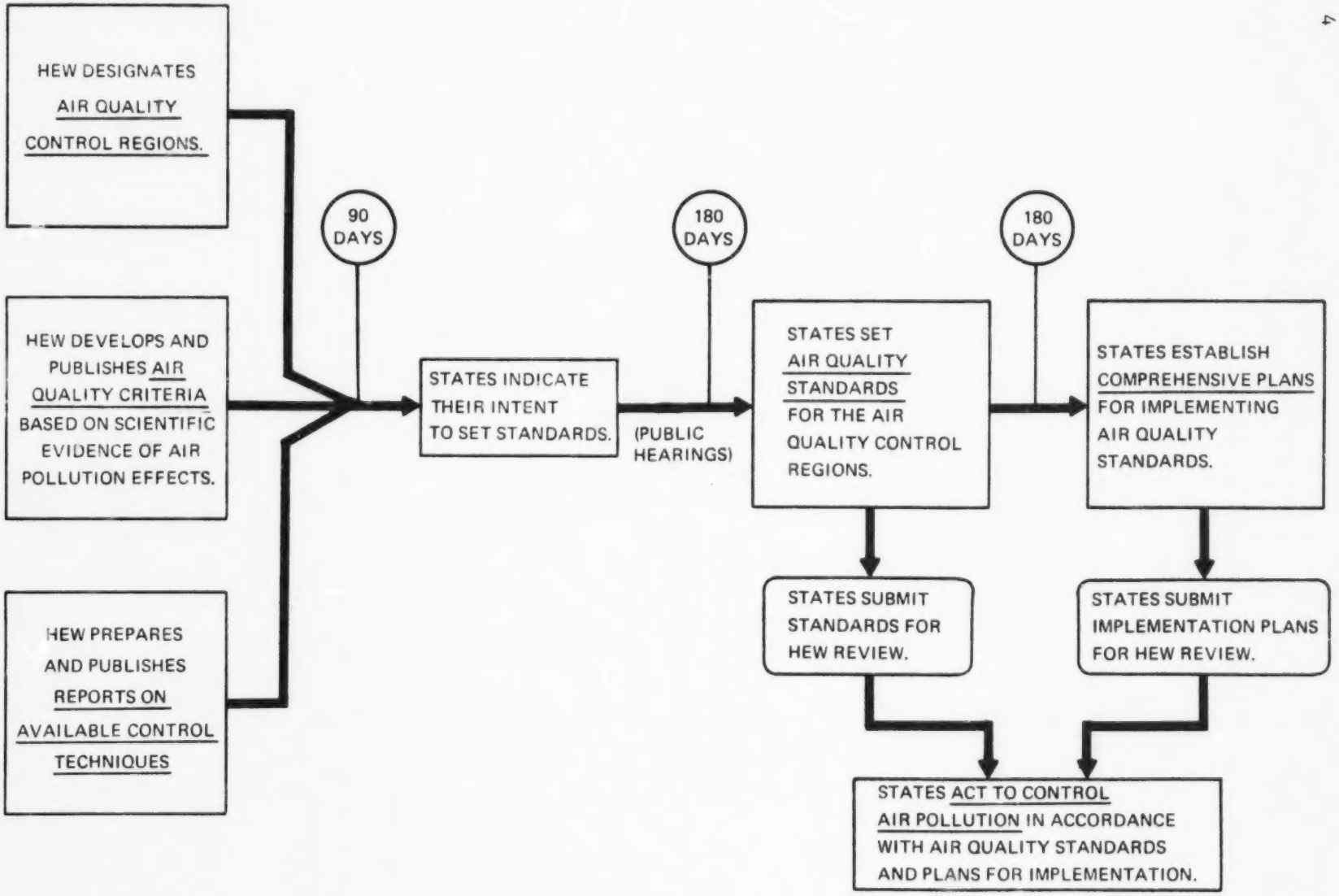
HEW DESIGNATES AIR QUALITY CONTROL REGIONS.
HEW DEVELOPS AND PUBLISHES AIR QUALITY CRITERIA BASED ON SCIENTIFIC EVIDENCE OF AIR POLLUTION EFFECTS.
HEW PREPARES AND PUBLISHES REPORTS ON AVAILABLE CONTROL TECHNIQUES
90 DAYS
STATES INDICATE THEIR INTENT TO SET STANDARDS.
180 DAYS
(PUBLIC HEARINGS)
STATES SET AIR QUALITY STANDARDS FOR THE AIR QUALITY CONTROL REGIONS.
180 DAYS
STATES ESTABLISH COMPREHENSIVE PLANS FOR IMPLEMENTING AIR QUALITY STANDARDS.
STATES SUBMIT STANDARDS FOR HEW REVIEW.
STATES SUBMIT IMPLEMENTATION PLANS FOR HEW REVIEW.
STATES ACT TO CONTROL AIR POLLUTION IN ACCORDANCE WITH AIR QUALITY STANDARDS AND PLANS FOR IMPLEMENTATION.

Figure 1 FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE AIR QUALITY ACT.

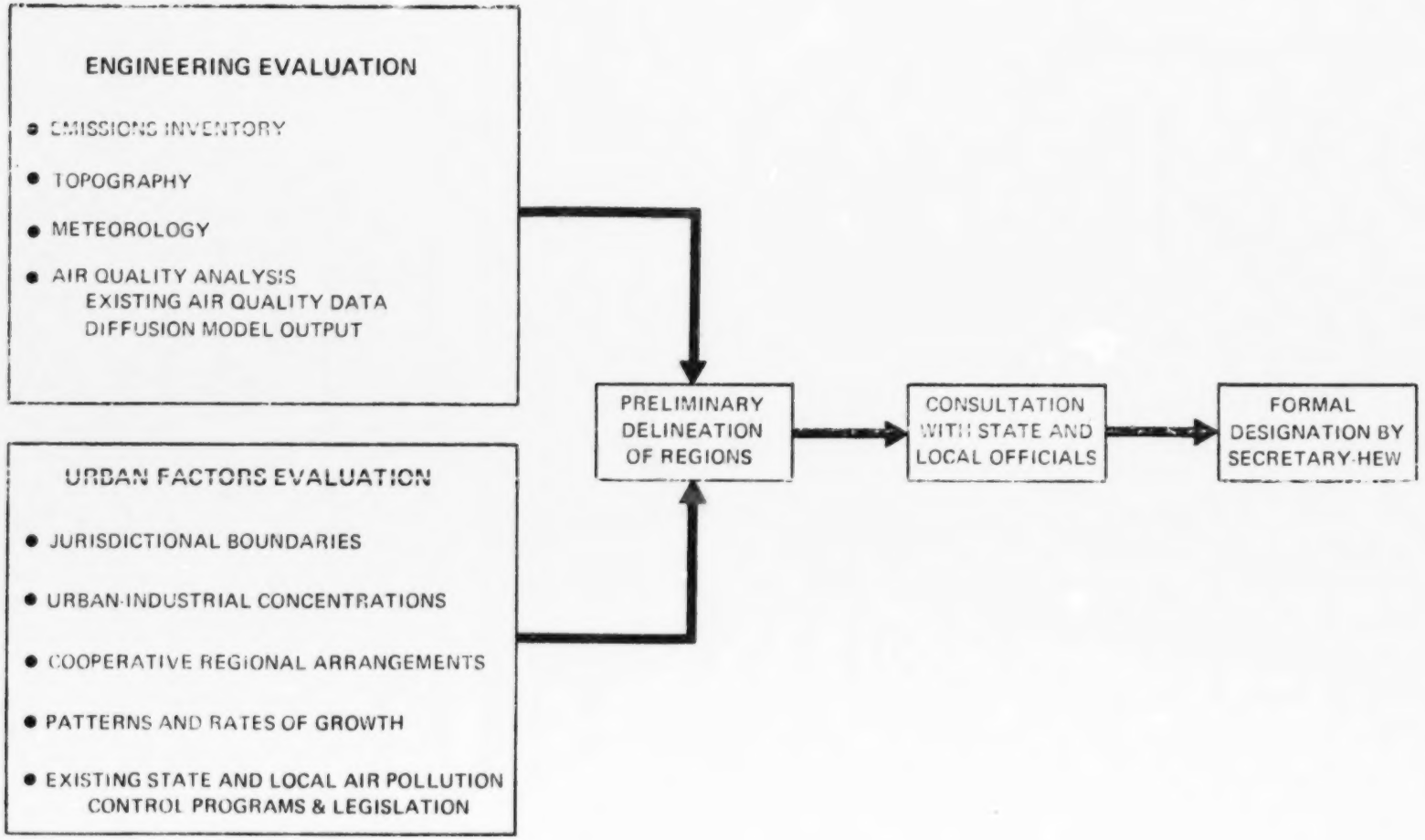
ENGINEERING EVALUATION
• EMISSIONS INVENTORY
• TOPOGRAPHY
• METEOROLOGY
• AIR QUALITY ANALYSIS
EXISTING AIR QUALITY DATA
DIFFUSION MODEL OUTPUT
URBAN FACTORS EVALUATION
• JURISDICTIONAL BOUNDARIES
• URBAN-INDUSTRIAL CONCENTRATIONS
• COOPERATIVE REGIONAL ARRANGEMENTS
• PATTERNS AND RATES OF GROWTH
• EXISTING STATE AND LOCAL AIR POLLUTION CONTROL PROGRAMS & LEGISLATION
PRELIMINARY DELINEATION OF REGIONS
CONSULTATION WITH STATE AND LOCAL OFFICIALS
FORMAL DESIGNATION BY SECRETARY-HEW

Figure 2. FLOW DIAGRAM FOR THE DESIGNATION OF AIR QUALITY CONTROL REGIONS.

and local authorities a report of the evaluation study (such as this "Report for Consultation") which includes the boundary proposal. At the consultation meeting State and local authorities are encouraged to present fully their views and suggestions concerning the proposed boundaries of the region. Interested parties who do not have official status may submit comments in written form for the record. After careful review of all suggestions and opinions submitted for the record by interested parties, the Secretary of Health, Education, and Welfare makes a formal designation of the region boundaries and notifies the Governor(s) of the State(s) affected by the designation.

The Size of a Region

As stipulated in Section 107 (a) (2), the designation of air quality control regions should be based on "jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards." This language suggests a number of objectives which are important in determining how large an air quality control region should be. Basically, these objectives can be divided into three separate categories.

First, a region should be self-contained with respect to air pollution sources and receptors. In other words, a region should include most of the important sources in the area as well as most of the people and property affected by those sources. In this way, all the major elements of the regional problem will lie within

one unified administrative jurisdiction. Unfortunately, since air pollutants can travel long distances, it is impractical if not impossible to delineate regions which are completely self-contained. The air over a region will usually have at least trace amounts of pollutants from external sources. During episodic conditions, such contributions from external sources may even reach significant levels. Conversely, air pollution generated within a region and transported out of it can affect external receptors to some degree. It would be impractical and inefficient to make all air quality control regions large enough to encompass these low-level trace effects. The geographic extent of trace effects overestimates the true problem area which should be the focus of air pollution control efforts. Thus, the first objective, that a region be self-contained, becomes a question of relative magnitude and frequency. The dividing line between "important influence" and "trace effect" will be a matter of judgment. The judgment should be based on estimates of the impact a source has upon a region, and the level of pollution to which receptors are subjected. In this respect, annual and seasonal data on pollutant emissions and ambient air concentrations are a better measure of relative influence than short term data on episodic conditions.

The second general objective requires that region boundaries be designed to meet not only present conditions but also future conditions. In other words, the region should include areas where

industrial and residential expansion are likely to create air pollution problems in the foreseeable future. This objective requires careful consideration of existing metropolitan development plans, expected population growth, and projected industrial expansion. Such considerations should result in the designation of regions which will contain the sources and receptors of regional air pollution for a number of years to come. Of course, region boundaries need not be permanently fixed, once designated. Boundaries should be reviewed periodically and altered when changing conditions warrant readjustment.

The third objective is that region boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. Air pollution is a regional problem which often extends across several municipal, county, and even State boundaries. Clearly, the collaboration of several governmental jurisdictions is a prerequisite to the solution of the problem. Therefore, the region should be delineated in a way which encourages regional cooperation among the various governmental bodies involved in air pollution control. In this regard, the existing pattern of governmental cooperation on the whole range of urban problems may become an important consideration. Certainly the pattern of cooperation among existing air pollution control programs is a relevant factor. In general, administrative considerations dictate that governmental jurisdictions should not be divided. Although it would be impractical

to preserve State jurisdictions undivided, usually it is possible to preserve the unity of county governments by including or excluding them in their entirety. Occasionally, even this would be impractical due to a county's large size, wide variation in level of development, or striking topographical features.

To the extent that any two of the above three objectives lead to incompatible conclusions concerning region boundaries, the region must represent a reasonable compromise. A region should represent the best way of satisfying the three objectives simultaneously.

As noted above, the evaluation of relevant technical factors and urban factors forms the basis of the boundary proposals published by NAPCA. The evaluation of technical factors is designed to indicate, where possible, the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. The quantity, locations, and nature of air pollutant emissions are determined by conducting an inventory of the various pollutant generators in an area. The transport and distribution of pollutants in the ambient air are analyzed on the basis of measured air quality data, the location of emissions, meteorological data, and topographic information. A mathematical diffusion model, which predicts ambient pollution concentrations from information on emissions and meteorology, can be used in areas where irregular topographical features would not invalidate the theoretical model.

As a whole, the technical study indicates how large the air quality control region must be in order to encompass most pollution sources and most people and property affected by those sources.

The study of urban factors encompasses a different set of considerations. It reviews existing governmental jurisdictions, the location of urban and industrial concentrations, expected patterns of urban growth, cooperative regional arrangements, existing State and local air pollution control programs, and other associated factors. The study of urban factors is designed to indicate how large a region must be in order to encompass expected regional growth and to encourage cooperation among political units in controlling air pollution.

The body of this report contains a proposal for the boundaries of the Hawaiian Islands Intrastate Air Quality Control Region and outlines the evaluation of technical and urban factors which was the basis of the proposal. The report is intended to serve as the background document for the formal consultation with appropriate State and local authorities.

EVALUATION OF ENGINEERING FACTORS

POLLUTANT EMISSIONS INVENTORY

The compilation of an air pollutant emissions inventory makes possible the correlation of pollutant emissions by type and quantity with specific geographic locations. This procedure is basic to a study of the nature of the air pollution problem in any area.

An emissions inventory of the State of Hawaii was conducted by the National Air Pollution Control Administration in cooperation with the Hawaii State Department of Health.[1] The Public Health Service rapid survey technique was used for the estimation of pollutant emissions. These emissions were calculated from data representative of the year 1968.

Hawaii consists of four counties* which include the eight major islands within the State (shown in Figure 3). Table I provides a county breakdown of sulfur oxide, total particulate, carbon monoxide, hydrocarbon and nitrogen oxide emissions by source category and type. As indicated in Table I, the majority of the pollutant emissions are attributable to sources located on the Island of Oahu. For this reason the emissions survey was conducted in a more detailed manner for Oahu. Table I indicates, however, that in most cases the remaining

1. State of Hawaii Air Pollutant Emission Inventory. U.S. Department of Health, Education, and Welfare; Public Health Service; National Air Pollution Control Administration: Durham, N.C., January, 1970.

* Kalawao County is part of the Island of Maui and is under the direct jurisdiction of the State government for most administrative purposes. It is considered as a distinct county only by the State Judicial Administration. Kalawao County is officially considered to be part of Maui County for statistical purposes. For these reasons air pollutant emissions from Kalawao County are included in the Maui County totals.

TABLE 1. SUMMARY OF AIR POLLUTANT EMISSIONS IN THE STATE OF HAWAII, 1968 (TONS/YEAR)

		Transportation			Fuel Combustion in Stationary Sources			Solid Waste Disposal						
	COUNTY	Motor Vehicles	Aircraft	Vessels	Residential Commercial Institutional	Industry	Steam-Electric Utility	Open-Burning	Incin-eration	Industrial Process Losses	Evaporative Losses	Agricul-ture	County Total [1]
Sulfur Oxides	Hawaii	100	N	170	180	13	3,200	60	N	N	N	1,200	4,900
	Honolulu	760	N	1,760	2,300	5,100	30,500	570	180	6,400	N	1,300	48,900
	Kauai	50	N	70	70	9	5	20	N	N	N	580	800
	Maui	70	N	110	140	14	2,400	50	N	N	N	2,600	5,400
	Total	980	N	2,110	2,690	5,140	36,100	700	180	6,400	N	5,680	60,000
Total Particulates	Hawaii	170	90	25	40	6	80	940	N	N	N	16,200	17,600
	Honolulu	1,100	600	220	220	440	1,010	9,000	660	4,400	N	9,600	27,200
	Kauai	70	13	7	17	4	2	390	N	N	N	12,100	12,600
	Maui	110	100	17	23	7	70	760	N	N	N	12,000	13,100
	Total	1,450	800	270	300	460	1,160	11,090	660	4,400	N	49,900	70,500
Carbon Monoxide	Hawaii	22,700	3,100	42	3	1	N	5,200	N	N	N	26,000	57,000
	Honolulu	184,000	9,800	280	19	26	4	47,800	1,300	40	N	19,000	262,300
	Kauai	10,500	96	9	N	1	N	2,000	N	N	N	25,000	37,500
	Maui	15,900	1,800	21	1	1	N	4,000	N	N	N	21,000	42,700
	Total	233,100	14,740	350	20	30	N	59,000	1,300	40	N	91,000	399,500
Hydro-carbons	Hawaii	2,900	660	23	2	1	40	1,500	N	N	1,400	810	7,600
	Honolulu	23,800	2,200	190	18	94	320	16,900	70	1,100	13,200	610	58,500
	Kauai	1,350	39	6	N	1	1	720	N	N	580	800	3,500
	Maui	2,100	380	15	1	1	20	1,400	N	N	1,020	730	5,700
	Total	30,150	3,280	230	20	100	380	20,820	70	1,100	16,200	2,950	75,300
Nitrogen Oxides	Hawaii	1,300	210	60	230	40	780	660	N	N	N	1,100	4,400
	Honolulu	10,000	870	560	950	2,500	10,500	6,200	190	1,200	N	970	33,900
	Kauai	580	18	20	90	23	16	260	N	N	N	920	1,900
	Maui	880	150	40	120	35	650	520	N	N	N	1,800	4,200
	Total	12,760	1,250	680	1,390	2,600	11,950	7,640	190	1,200	N	4,790	44,400

NOTE: Kalawao County Emissions Included in Maui County Totals.

1. Rounded Totals

N = Negligible

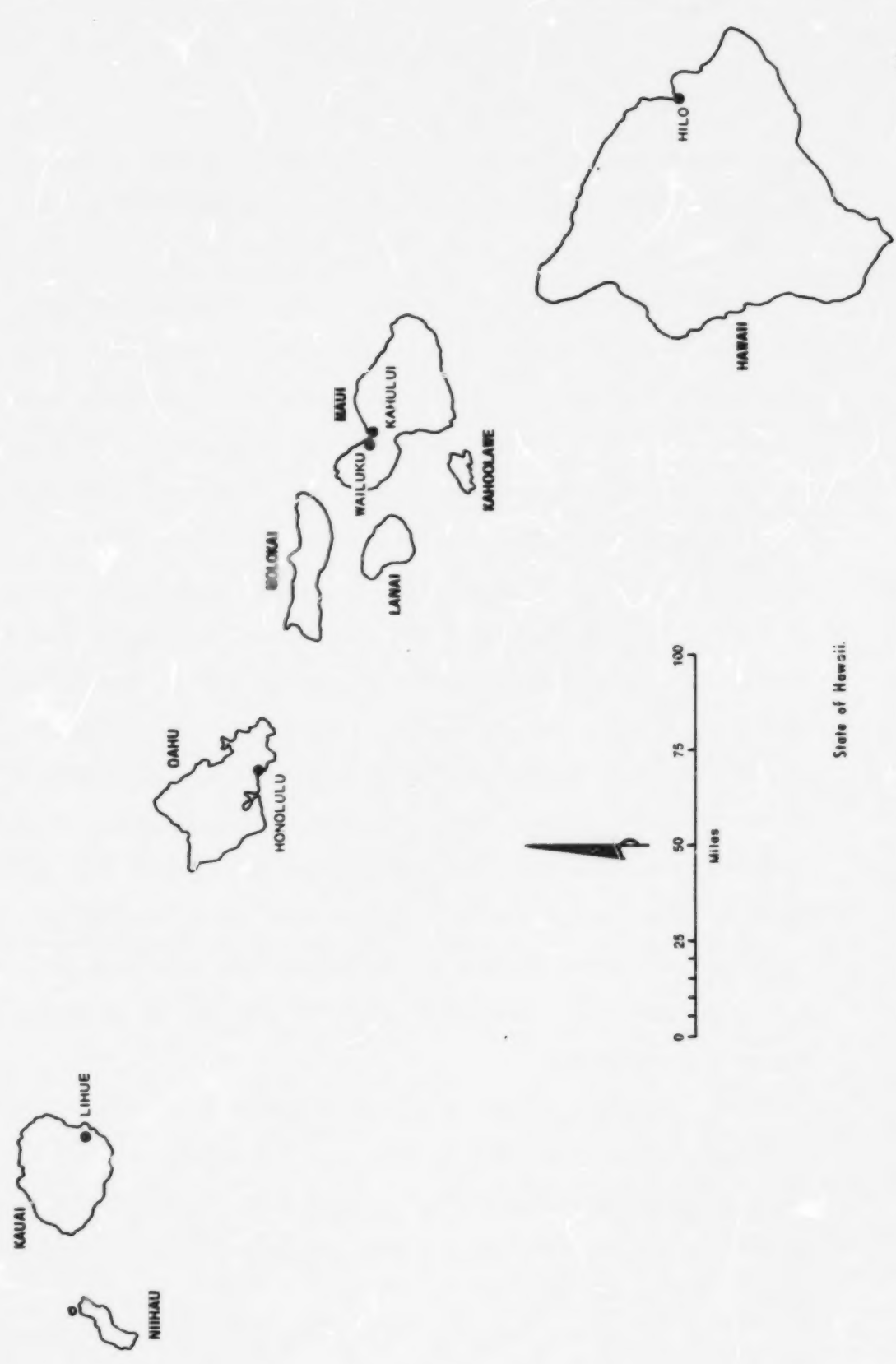

FIGURE 3. EMISSIONS INVENTORY SURVEY AREA.

counties contribute significant quantities of the various pollutants to the State total. Following is a brief discussion of the results of the Hawaiian Islands emissions survey.

Honolulu County, which is coterminous with the Island of Oahu, and which contains the capital City of Honolulu, contains 80% of the population and about 72% of the manufacturing employment in the State. Approximately 82% of the SO_x, 38% of the particulate matter, 66% of the CO, 78% of the hydrocarbons and 76% of the NO_x emissions in the State are from sources in Honolulu County. The primary source of SO_x in Oahu are the three power plants which burn residual fuel oil. These power plant locations are shown in Figure 4 along with other major point source locations on Oahu. The power plants are also responsible for a significant share of the NO_x emitted on the Island. Motor vehicles are responsible for the majority of the CO emissions and a major portion of the total NO_x and hydrocarbon emissions. The open-burning of solid wastes is responsible for a substantial share of the total particulate, carbon monoxide, hydrocarbon and nitrogen oxide emissions. In addition, cane field burning and bagasse incineration create large quantities of particulate emissions. Industrial processes are substantial sources of SO_x and total particulates.

Source locations within the Island of Oahu were accurately determined by use of the grid coordinate system shown in Figure 5. Figures 6, 7, and 8 present emission densities for SO_x, total particulates, and CO, based on the Oahu grid system. SO_x emissions are greatest in the grid zones

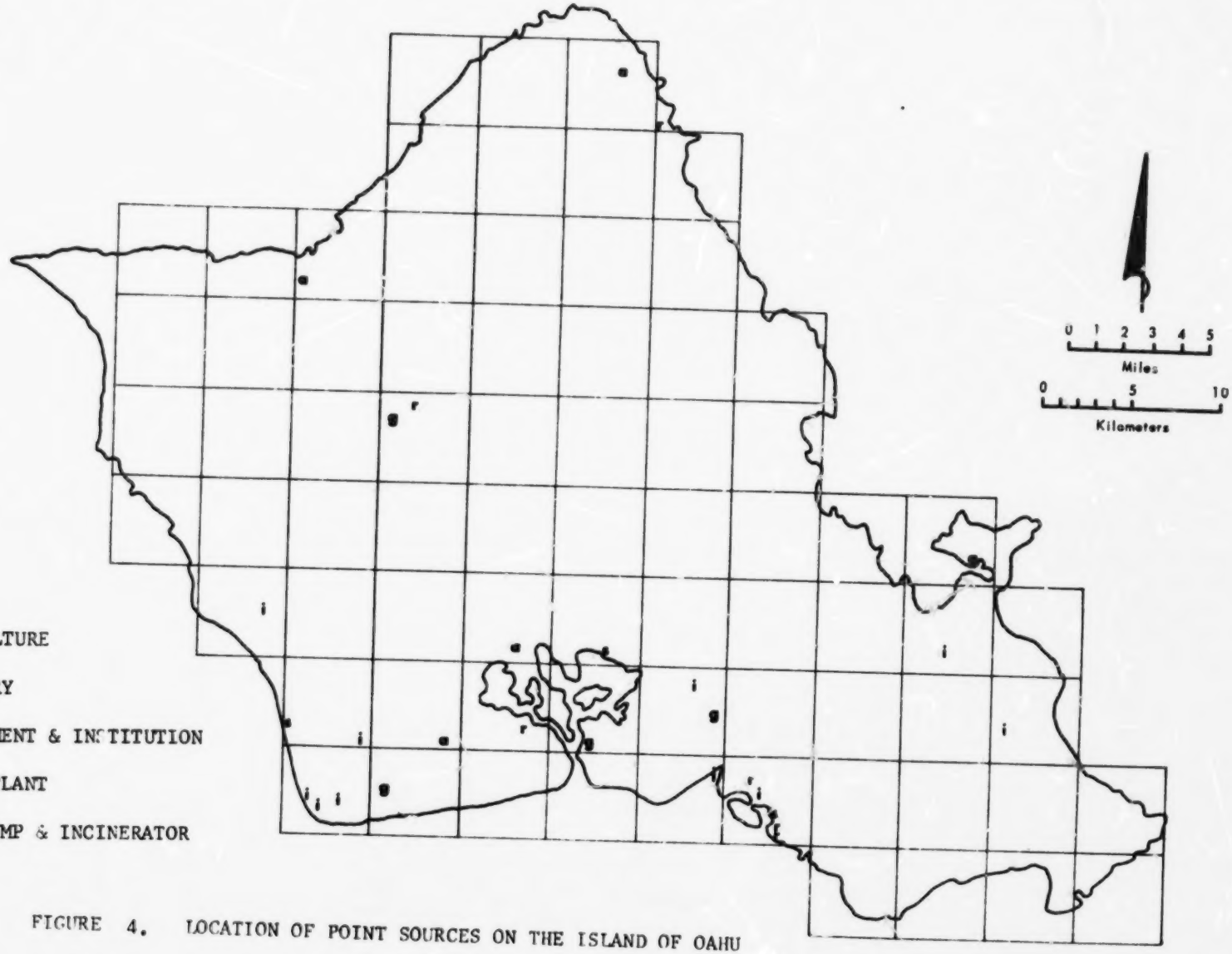

FIGURE 4. LOCATION OF POINT SOURCES ON THE ISLAND OF OAHU

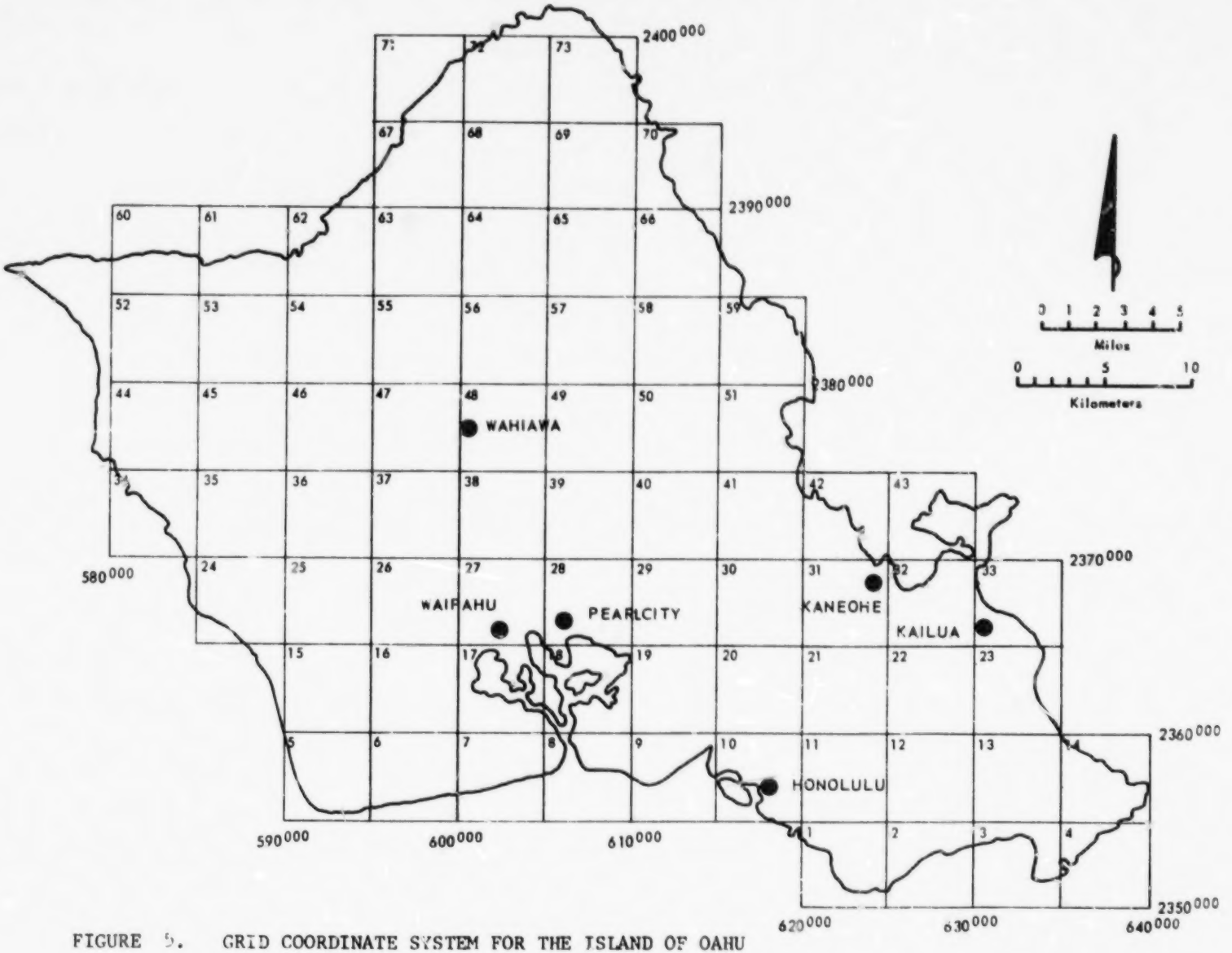

FIGURE 5. GRID COORDINATE SYSTEM FOR THE ISLAND OF OAHU

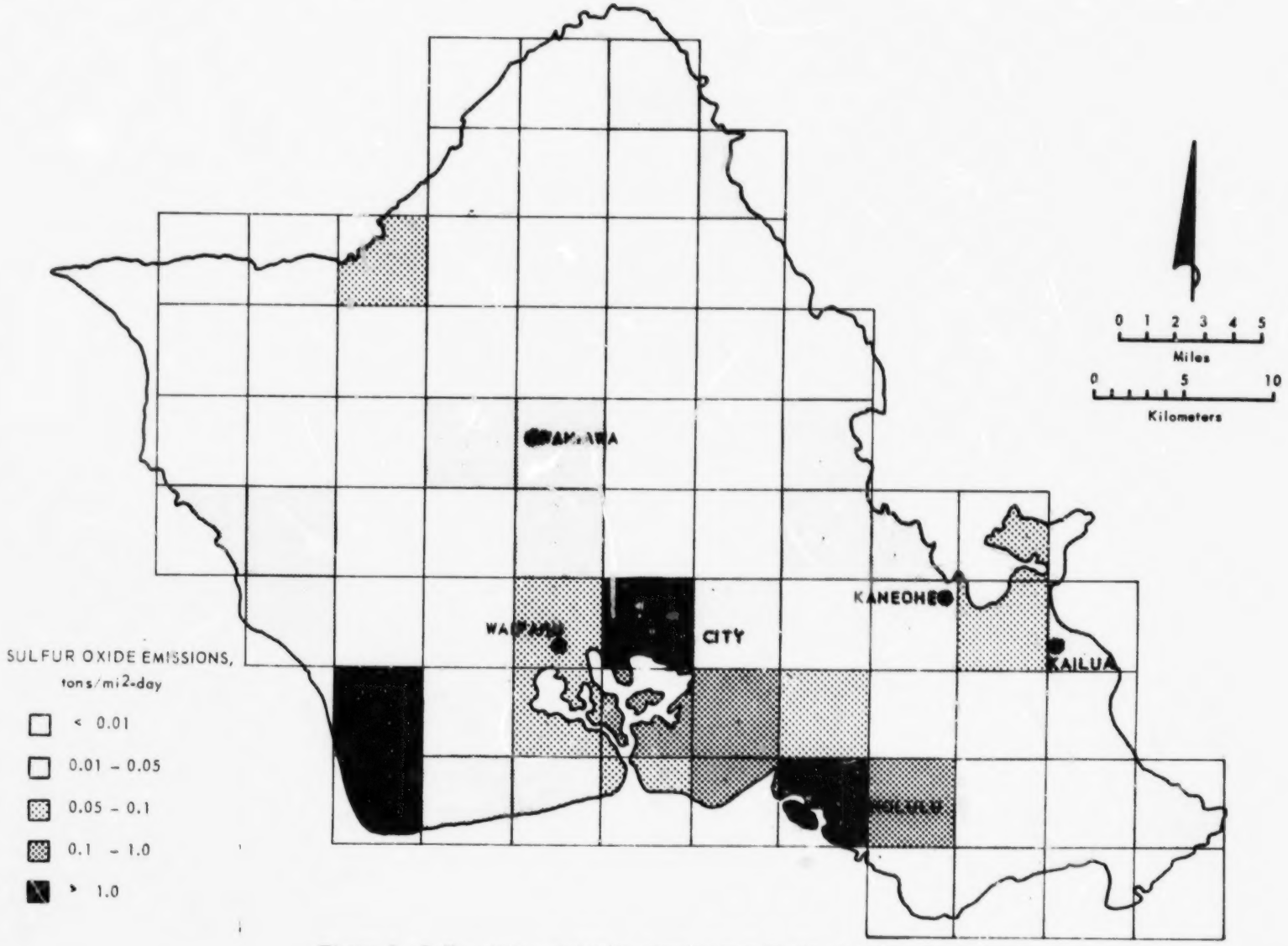

Figure 6. Sulfur oxides emission density map of the Island of Oahu, 1968.

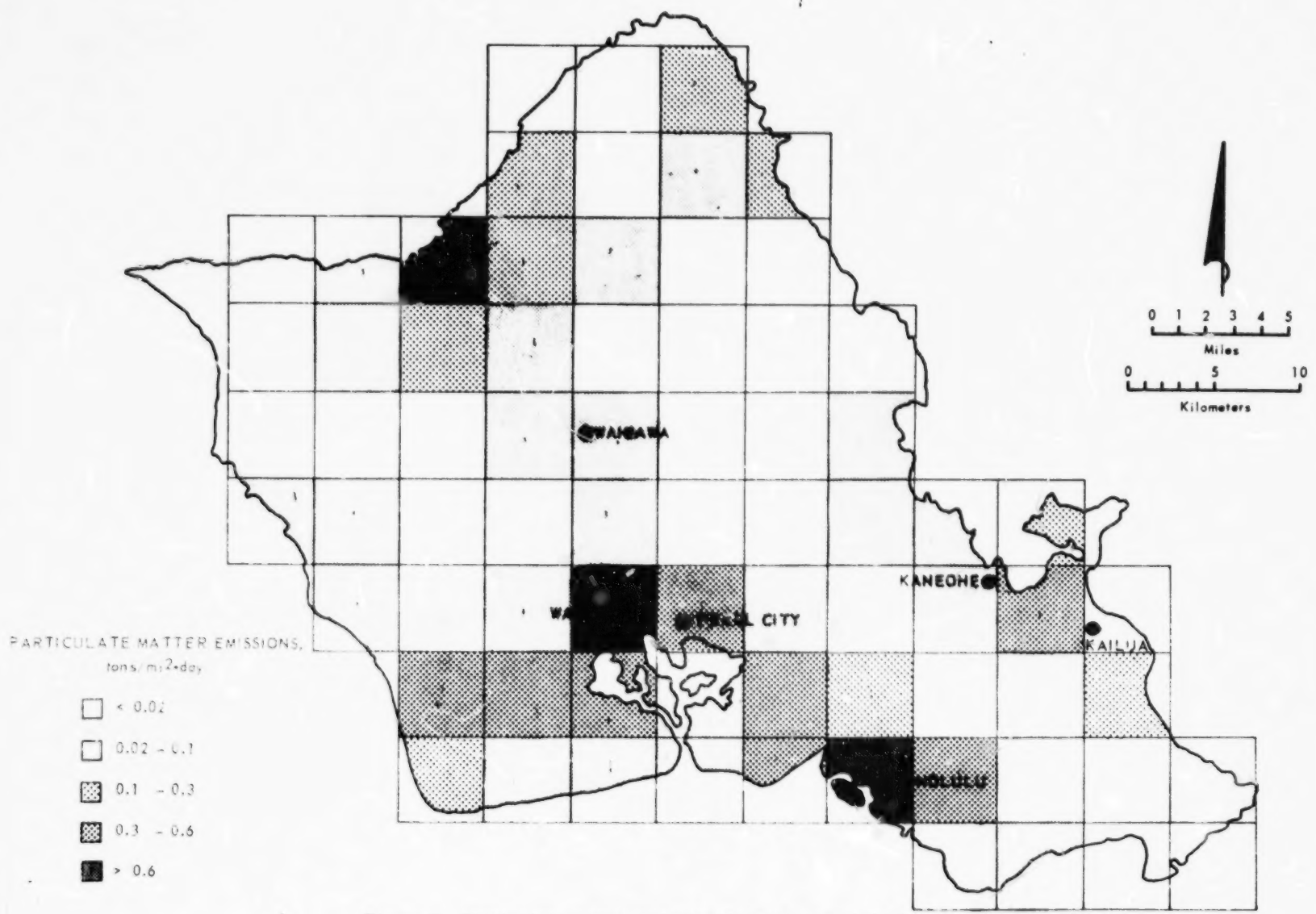

Figure 7. Particulate matter emission density map of the Island of Oahu, 1968.

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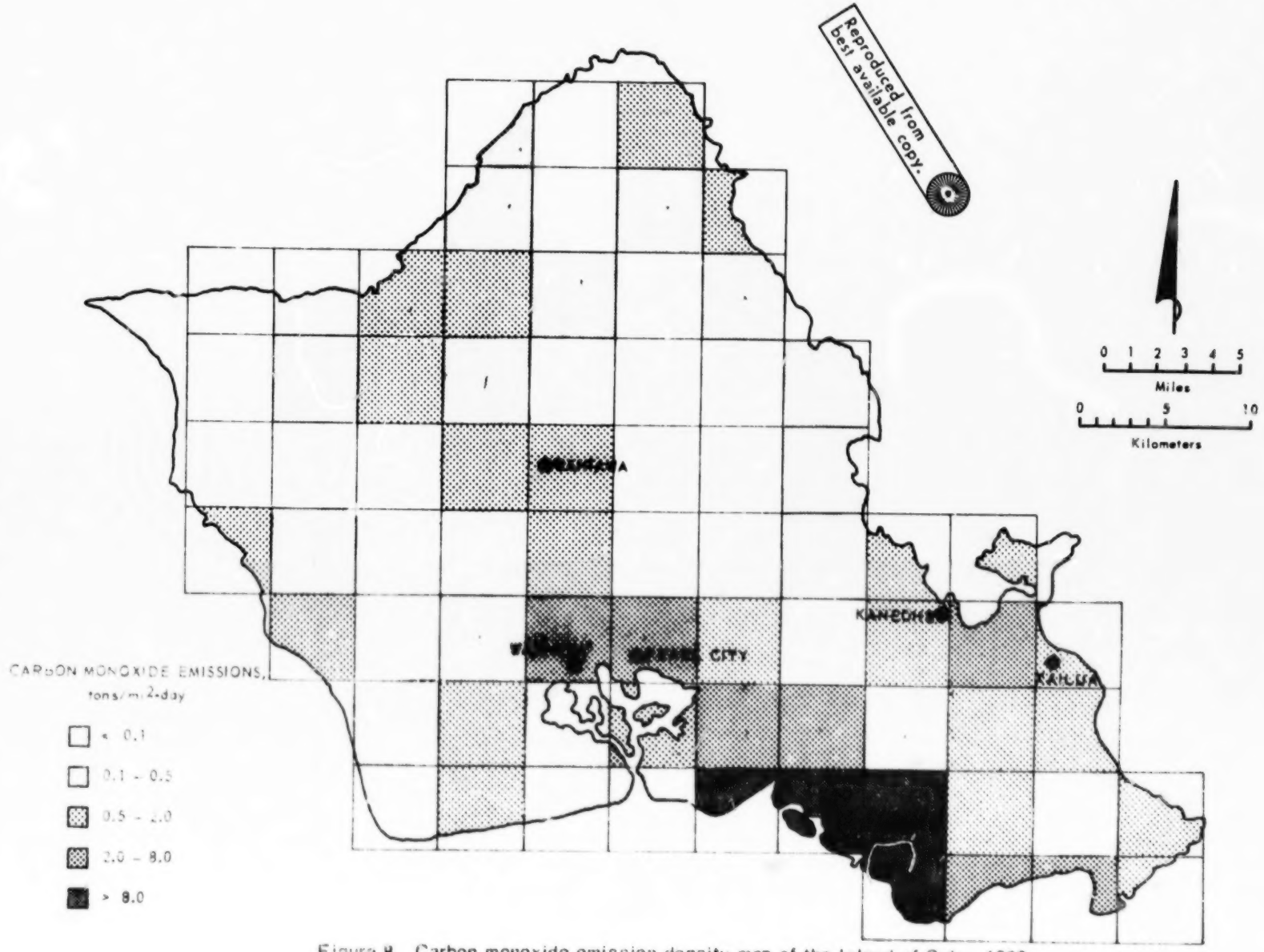

Figure 8. Carbon monoxide emission density map of the Island of Oahu, 1968.

containing the power plants and a petroleum refinery. Particulate emissions similarly are greatest in the locations of major point sources and at the location of sugar mill and cane field-burning activities. Carbon monoxide densities are highly related to the urban patterns on Oahu. Thus, CO emissions are, as expected, greatest in the core of the City of Honolulu.

The County of Hawaii ranked second to Oahu in quantity of pollutants emitted (91,500 tons/year). The major contributors to pollutant emissions on the Island of Hawaii are power plants (SO_x), motor vehicles (CO, NO_x, and hydrocarbons) and agricultural activities (particulate matter, CO and NO_x). The precise contributions of each pollutant from the various sources may be found in Table I.

Maui County, which consists of four islands, was responsible for a total of 71,100 tons of pollutants in 1968. The major sources of SO_x in these islands are stationary fuel combustion sources and agricultural activities. Agricultural activities also contribute 92% of the total particulate emissions. Motor vehicles and agriculture contribute 86% of the CO emitted, while NO_x and hydrocarbon emissions are distributed among the various sources.

The primary sources of all the five air pollutants inventoried in Kauai County, which is comprised of two islands, are agricultural operations and motor vehicles. All other source types are negligible in comparison.

AIR QUALITY

Introduction

The regional approach to air resource management requires that those jurisdictions containing the majority of the sources of pollution in a metropolitan area be included within a single air quality control region. A region should also include jurisdictions containing the majority of the people and property adversely affected by air pollutant emissions from those same sources. The core area of a region can be roughly defined on the basis of pollutant point source locations and relative emission densities. However, information on present levels of pollution in the ambient air is helpful in order that outlying pollutant receptor areas can be identified. The selection of an essentially self-contained region will result - a region which will include within its bounds virtually the entire source-receptor system for a particular area.

The following sections discuss briefly the factors likely to affect air pollution potential in the State of Hawaii. These factors are topography and meteorology. In addition, a brief discussion of existing air quality is presented. The meteorological diffusion model was not applied to Hawaii since the extreme topographical irregularities and the geographic relation of the Islands to one another would not provide useful or reliable estimates of air quality.

Meteorology, Topography and Measured Air Quality

Atmospheric circulation is Hawaii is usually dominated by the large North Pacific high pressure system located to the east and north of the Islands. This system throughout the year produces a rather persistent flow of air from the northeast known as the Northeast Trades. The Trades show a marked seasonal variation in frequency and speed. They occur about 94% of the time in July but only 50% in January. The yearly average frequency of occurrence is about 74%. The stronger Trade winds*--those most effective in dispersing air pollution--however, occur only about 86% of the time in July and 33% of the time in January. In addition, the Trades may be absent weeks at a time, especially between October and April, so that pollutants will not be readily dispersed.

Wind speeds at Honolulu Airport greater than 7 mph, regardless of direction, occur about 87% of the time in July, but only 57% in January. Calms occur about 5-10% of the time between evening and morning during July, but occur up to 30% of the time during the night and early morning in January. Thus, winds at Honolulu Airport are not effective in significantly influencing pollutant mixing and transport for a great portion of many days throughout the year.

During the absence of the Trades, Kona storms may create strong southerly winds which sweep pollutants to the inland areas of Oahu. Kona weather, on the other hand, is characterized by long periods of light winds, a stable and cool lower atmosphere, and shallow inversion

* Wind speeds greater than 7 mph

levels. In the Honolulu area particularly, these conditions create the inland flow of pollutants by the sea breezes which occur during the day. Also, fumigation conditions are created during the mornings as nocturnal inversions are disrupted by the sun's warming of the earth. These conditions are sometimes evident during periods of light Trade winds.

The remarkable heights of all the Hawaiian Islands are a chief determinant of the climate. The Island of Kauai is composed of a central mountain mass rising to about 5,000 feet above sea level. The Island of Maui consists of a relatively broad central valley bordered by mountains to the west and southeast whose elevations rise to a maximum of about 10,000 feet. Molokai and Lanai have mountainous terrain rising to nearly 5,000 feet. The center of the Island of Hawaii is a mountain mass, rising to 13,000 feet and surrounded by gradually sloping coastal plains. Oahu consists of a valley bordered by mountain systems along its western and northeastern coasts. This irregular topography in turn has a complex and varied effect upon air pollution potential in Hawaii.

All the Islands contain areas partially or entirely shielded from the Trades by the mountains. In other areas topography significantly alters the direction, speed and turbulence of the wind. The western coast of Oahu, the southern sides of Hawaii and east Maui for example, are areas sheltered from all but the strongest Trade Winds. In these areas the prevailing winds are light and not turbulent and pollutant

dispersion is likely to be poor. Topography also tends to channel winds in valley areas creating fumigation conditions, as is the case in Maui's central valley. In certain areas, such as Hilo, topography creates a condition whereby pollutants are blown out to sea during evenings and mid-morning and are blown back on shore during the day.

Existing air quality data for the State of Hawaii is very limited. Most of the data has been collected at the Department of Health Building in Honolulu. Suspended particulate pollution has been monitored at this site since 1957 when Hawaii first became part of the National Air Surveillance Network. From 1957 through 1961 the geometric mean concentration of suspended particulates equalled 48.8 $\mu g/m.^3$. From 1962 through 1966 the geometric mean concentration dropped significantly to 38.7 $\mu g/m.^3$, thus indicating a long term downward trend during those years. In 1967 and 1968 the annual geometric mean concentrations were 36 and 42 $\mu g/m.^3$, respectively. The geometric mean suspended particulate concentration between 1957 and 1968 equalled 43 $\mu g/m.^3$. Greatest concentrations were usually recorded during the winter months while lowest particulate concentrations were recorded during the summer. The maximum concentration during a 24 hour period in 1968 equalled 83 $ug/m.^3$.

Sulfur dioxide, notrogen dioxide and total oxidant measurements for various averaging times at the Health Department Building are presented in Table II.

TABLE II. AIR QUALITY DATA - HONOLULU, HAWAII

	Maximum Hour	Maximum Day	1967-1969 Annual Average	1969 Annual Average
Sulfur Dioxide	120 µg/m.^{3} (.045 ppm)	65 µg/m.^{3} (.025 ppm)	16 µg/m.^{3} (.006 ppm)	16 µg/m.^{3} (.006 ppm)
Nitrogen Dioxide	145 µg/m.^{3} (.077 ppm)	62 µg/m.^{3} (.033 ppm)	23 µg/m.^{3} (.012 ppm)	21 µg/m.^{3} (.011 ppm)
Total Oxidants	80 µg/m.^{3} (.040 ppm)	25 µg/m.^{3} (.013 ppm)	- -	3 µg/m.^{3} (.001 ppm)

Although some air quality data is available for other sites in the State, it is either out of date or too limited in time to be representative of actual conditions.

EVALUATION OF URBAN FACTORS

INTRODUCTION

The Clean Air Act calls for the designation of air quality control regions based on "jurisdictional boundaries, urban-industrial concentrations, and other factors" to provide an intergovernmental system for the prevention and control of air pollution. The designation of air quality control regions must also be based on a consideration of existing cooperative regional arrangements, population concentrations, location of industry, and patterns and rates of urban growth. The following discussion will present these considerations as they apply to the State of Hawaii.

POPULATION DISTRIBUTION

Human activity in its many forms is the basic cause of air pollution. Thus, existing and potential air pollution problems may be related to geographic areas by studying present and projected population statistics for those areas. Population data for the State of Hawaii is presented in Table III.

For the past five decades the population growth of the State of Hawaii has centered on the city of Honolulu, located on the Island of Oahu. Largely due to the rapid growth in Honolulu City, the population of Honolulu County (Oahu) increased 147% between 1930 and 1960. During the same period, however, the

TABLE III. POPULATION AND EMPLOYMENT DATA
BY JURISDICTION

County	Land Area (Mi.^{2})	1960 Population[1]	1969 Estimated Population[2]	1980 Projected Population[3]	1969 Pop. Density (Persons/Mi.^{2})	1980 Projected Pop. Density (Persons/Mi.^{2})	Additional Residents 1969-1980	Per Cent Growth 1969-1980	Estimated 1963 Manufacturing Employment
Hawaii	4,037	61,332	67,229	69,486	17	17	2,257	3.2	2,367
Honolulu	596	500,409	645,319	930,000	1,082	1,560	284,681	44.0	18,045
Kauai	619	28,[illegible]	31,666	32,242	51	52	574	1.9	1,176
Maui	1,173	42,855	49,533	54,798	42	47	5,265	10.5	2,956
State Total	6,425	632,772	793,747	1,086,526	124	169	292,779	36.9	25,144

1. U. S. Census of Population
2. Hawaii State Department of Health and Department of Planning and Economic Development
3. General Plan Revision Program, Part IV; State Department of Planning and Economic Development
4. Commercial Atlas and Marketing Guide; 100th Edition; Rand McNally & Co., 1969

aggregate population of the counties of Kauai, Maui, and Hawaii decreased by 20%.

Between 1960 and 1969 the population of Oahu increased 29%, while that of the Neighbor Islands increased about 12%. Numerically, Oahu increased from 500,409 to 645,319 persons; the Neighbor Islands increased from 132,363 to 148,428 persons. These figures indicate that at the present the Island of Oahu contains over four-fifths of the entire population of the State. Since Oahu comprises less than 10% of the States' total land area, it is by far the most densely populated Island. Of those persons living on Oahu 335,000, or about 52%, reside in the city of Honolulu. Thus, the population density in Honolulu City is far greater than that indicated in Table III for the entire Island. Due in large part to the great concentration of residents in Honolulu, over 75% of the population in Hawaii is classified as "urban."

The concentration of population on Oahu has been largely due to the sharp decline in plantation employment in the neighboring counties because of mechanization, and to the complex interaction of major growth factors (including military growth) in and around Honolulu. The information provided by Table III indicates that Honolulu City and County will continue to grow at a rate which is disproportionate to the growth rate of the State as a whole. 1980 population estimates for Honolulu indicate that 480,000 persons will reside in that City. At that time Oahu is

expected to have a population of 930,000 persons. Thus, Honolulu City will continue to serve as the metropolitan core for the rural areas of Oahu and for the State as a whole.

The present populations of Hawaii, Maui and Kauai Counties are approximately 67,000, 50,000 and 31,500 persons, respectively. These counties are expected to continue to grow at a relatively modest rate. The increasing number of jobs relating to the growing tourist industry has been a factor in reversing the trend toward a population decline in these three Counties. Part of the reasons for the recent population increases in Maui County has been an increase in small industries in addition to the impact of tourist activity. The rise in population in Hawaii County has been stimulated not only by tourism but also by new industrial and agricultural enterprises and the exploitation of markets for several of its agricultural products. Kauai County's growth in recent years has been due to increased tourism and the expansion of military and space facilities. All these factors will continue to result in population increases as reflected by the population projection data in Table III.

The city of Hilo, with a population of 26,000, ranks second in size to Honolulu in the State. Hilo is located on the Island of Hawaii. The largest towns on the Island of Kauai are Lihu and Kapaa, with respective populations of 4,300 and 3,500. The majority of the people in Maui County are located on the Island of Maui.

The twin towns of Wailuku and Kahului contain populations of 7,500 and 5,000, and are the business centers of the County. Most of the County's growth is expected to be in these two areas. The Islands of Molokai and Lauai contain about 5,000 and 2,000 persons respectively, most of whom are rural.

MANUFACTURING AND GENERAL ECONOMIC ACTIVITY

The location of manufacturing and other economic activity is helpful in determining the size of an air quality control region. Industrial, agricultural, and other product and income generating activities are often substantial contributors of air pollutant emissions. Following is a discussion of these factors as they apply to the State of Hawaii.

The dominating factor in the economy of Hawaii is the military and other Federal defense activities. The Hawaiian Islands, principally Oahu, serve as a center for supplies and personnel supporting Pacific military operations. Military expansion on the Island of Oahu has been one of the stimulants to the rising population concentration in and around Honolulu City. Although cut-backs are expected to decrease Hawaii's military activity by 1980, the Federal Government will remain a major factor in the economy of Oahu. Federal Government civilian employment and expenditures by State and local goverrments will continue to be major factors in the economy of the State, and

particularly Honolulu City and County.

The most important element in the private sector of the economy of Hawaii is agriculture. The sugar industry is still Hawaii's largest and most important single industry. The County of Hawaii produces by far the greatest quantity of sugar, followed by Maui and Kauai Counties, which produce about equal amounts. Ten sugar mills are located on Hawaii, while Kauai, Maui and Honolulu Counties contain eight, three and four mills, respectively. The burning of cane fields, and the incineration of bagasse at the mills are the most important source of agricultural air pollutants in the State.

Pineapple production follows sugar production as the most important agricultural activity in the State. Most of the pineapple production occurs on Oahu and in Maui County. Kauai produces a modest amount of pineapple, while none is grown on the Island of Hawaii. In summary, plantation agriculture in sugar and pineapple and their processing are the leading industrial activities in Kauai and Maui Counties, while sugar is the dominant industry in Hawaii County. Other important agricultural products in the State are milk, cattle, fruits and vegetables, coffee and poultry. Agricultural activities including pineapple and coffee production are related to localized air pollution problems (including odor problems) and are responsible for pollution from fuel combustion.

Employment in agriculture is expected to decrease in the years ahead, though it will remain an important sector of the economy. Much of this trend toward fewer employees has been caused by the mechanization of agriculture. Honolulu is the only County in Hawaii in which agricultural production is and will continue to be overshadowed by other activities. The agricultural activity in the other islands, however, gives balance and vital support to Oahu, and creates a continuous mutual interdependence among the Islands.

The bulk of the manufacturing activity in Hawaii is located on the Island of Oahu, as indicated by the employment information provided in Table III. The tendency toward concentration of industry in the Honolulu area has resulted because the County comprises the bulk of the local market for manufactured products. The Island of Oahu, does not, however, contain much heavy industry. Industry is principally in the light and medium categories. The exception to this are a petroleum refinery and a steel rolling mill. The petroleum refinery and the mineral products industry are the most significant industrial process sources of air pollutants. Other industrial activities on Oahu include sand and gravel operations, cement plants, metal foundary operations and asphalt batching, sugar and pineapple processing, fruit and food processing, lime and fertilizer production, garments and printing and publishing. Oahu's industry is chiefly located in and around

Honolulu City and at the southwest corner of the Island. Manufacturing in the neighboring islands, in contrast, is chiefly related to agriculture. There are, however, small manufacturing activities being introduced in these areas.

EXISTING REGIONAL ARRANGEMENTS

The geographic extent of regional planning commissions, councils of local governments, State-defined planning and economic development districts, and region-wide statistical data-gathering bases is an important consideration affecting the selection of air quality control region boundaries. The designation of a region compatible with these regional arrangements, where existing, is desirable since the implementation of a regional air pollution control plan is dependent upon cooperation at the various levels of government.

The concept of Standard Metropolitan Statistical Areas (SMSA's) has been developed to meet the need for the presentation of general-purpose statistics by agencies of the Federal Government, and by State and local governments. Each SMSA includes at least one city of 50,000 inhabitants, the county in which that city lies, and adjacent counties which are found to be metropolitan in character and economically and socially integrated with the county of the central city. Objective criteria of a quantitative character have been established to determine the existence of such multi-jurisdictional interdependency. On these bases, Honolulu County

has been designated as an SMSA.

Planning in Hawaii is conducted at the State level by the Department of Planning and Economic Development. The Department has been authorized by law to prepare a general plan of the State by working in close cooperation with county officials. The Department is further authorized to furnish planning assistance to the several counties to facilitate planned development in urban and rural areas. The individual counties do their own subplanning, although close cooperation is maintained between the State and the several county planning programs. In summary, the planning activities in the State of Hawaii are characterized by close intercounty cooperation and closely coordinated plans.

EXISTING AIR POLLUTION CONTROL PROGRAMS AND LEGISLATION

In the process of defining the boundaries of an air quality control region it is important to consider the role of existing State and local air pollution control programs. It is also important to review pertinent legislation which grants enforcement powers to these agencies and which allows for the promulgation of control regulations. Such consideration is desirable since the ultimate responsibility for implementing region-wide air quality standards rests with State and local governments.

Responsibility for the control of air pollution in Hawaii is vested with the Air Sanitation Branch of the State Department of Health. In accordance with the State Air Pollution Control Law

The Department of Health is directed to establish rules and regulations prohibiting air pollution throughout the State after public hearing. Such rules and regulations have been established for Honolulu and Maui Counties. The Health Department is further authorized to require all persons engaged in operations which may result in air pollution to secure a permit. The Department has the authority to make inspections to determine compliance with regulations. The State Law also gives the Department authority to establish air quality standards for the State as a whole or for any part of the State. The Law further provides for hearings regarding complaints, for the issuance of orders to correct violations, for relief in the courts and for penalties and appeals to those in violation of rules and regulations.

The State Department of Health may, according to the Law, organize county advisory air pollution control associations to study air pollution problems in their respective jurisdictions and to advise the Department. These associations also may review Department rules or regulations of strictly local application before adoption. The counties may adopt regulations and ordinances controlling air pollution and establishing county control agencies if they are not inconcistent with the State Law. Counties may also contract with each other and with the State for the sharing of services and for technical assistance and training.

FEDERAL INSTALLATIONS IN HAWAII

One of the natural advantages of Hawaii is its strategic location from a defense standpoint. Because of this, Federal military expenditures will no doubt continue to be the largest single source of income in the local economy as it has been for over a decade. The bulk of the Federal installations are located on the Island of Oahu, with small detachments and special units on the Neighbor Islands. Of the estimated 1969 military population of 56,729 for the State, all but 250 were stationed on Oahu.

Generally, military installations range from forested infantry training areas to the Pearl Harbor Naval Shipyard. Included are air bases, recreational facilities, housing developments, nuclear and electronic installations, a submarine base, and a variety of testing and repair facilities. Specifically, other major military facilities on Oahu include the Kaneohe Marine Corps Air Station, Hickam Air Force Base, and the Army's Schofield Barracks and Forts Shafter and Armstrong. The extent to which land on Oahu is utilized by Federal military installations is shown by the shaded portions of Figure 9.

Plans are being or have been prepared for the introduction of pollution control measures at many of Hawaii's defense installations, including the Army's Helemana Radio Station, the Schofield Barracks, and the Tripler Army Hospital. Air Force

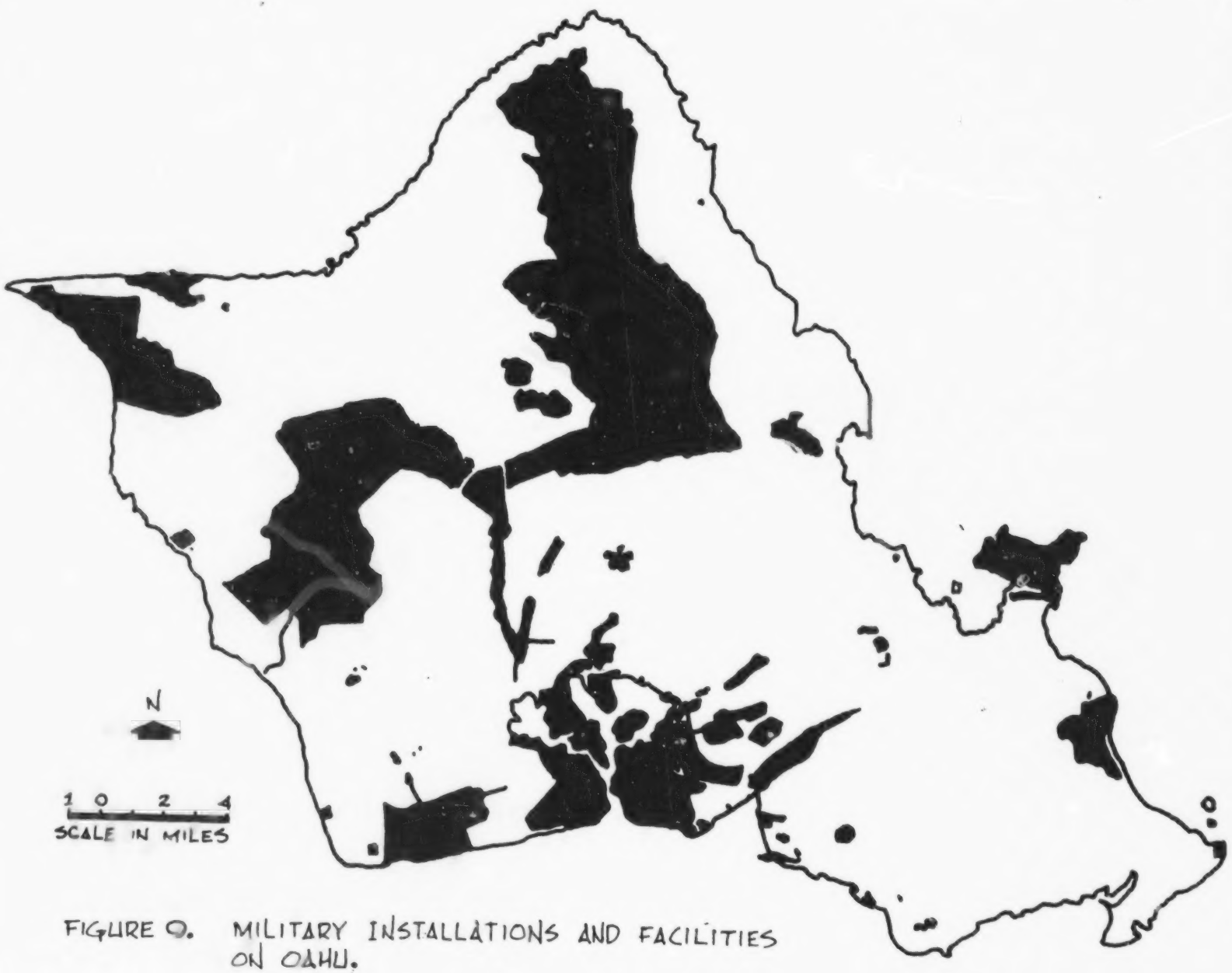

FIGURE 9. MILITARY INSTALLATIONS AND FACILITIES ON OAHU.

pollution control projects are being conducted at Bellows Air Force Station, Hickam Air Force Base, and Wheeler Air Force Base, among others. Projects are underway at the Pearl Harbor Naval Shipyard, the Kaneohe Marine Corps Air Station, the Naval Communications Station, and at other locations. Many of these pollution control measures have been designed to reduce pollution from incinerators, from fuel storage facilities, and to replace open-burning of waste materials with sanitary landfill operations.

The efforts to control air pollution from Federal facilities in Hawaii are directed toward compliance with the Presidential Executive Order 11507, which deals with the prevention, control, and abatement of air and water pollution at Federal facilities. This Order, issued on February 4, 1970, is intended to provide Federal leadership in the protection and enhancement of the air resource by requiring that by December 31, 1972 all Federal facilities be operated and maintained in conformance with air quality standards established pursuant to the Clean Air Act, as amended. The Order also established a nontransferable fund for achieving its objectives, and requires that all new Federal installations be designed to meet the requirements of the Order concerning air quality standards. In summary, the Executive Order is intended to establish the Federal Government as an effective leader in efforts to preserve the quality of the environment.

THE PROPOSED REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region consisting of the entire State of Hawaii. As so proposed, the Region would consist of the territorial area encompassed by the outermost boundaries of the State of Hawaii including the territorial area of all municipalities located therein as defined in Section 320(f) of the Clean Air Act, as amended (42 U.S.C. 1857h(f).

DISCUSSION OF PROPOSAL

To implement a successful air resource management program, an air quality control region should be large enough to encompass most air pollution sources as well as most people and property affected by those sources. The boundaries should also include those locations where present development creates, or where projected urbanization and industrialization will create, significant air pollution problems. Finally, the region should be compatible with or hopefully even foster unified and cooperative governmental administration of the air resource. The proposed Hawaiian Islands Intrastate Air Quality Control Region was designed to satisfy, in the best way, these requirements.

The air pollutant emissions inventory for the State of Hawaii indicated that the greatest quantities of all the pollutants surveyed were emitted in Honolulu County. This was expected since air pollution is highly related to population, and the bulk of Hawaii's population resides on Oahu. Air pollutant emissions from other activities - especially agriculture - are significant not only on Oahu, however, but also on the Neighbor Islands. Other source types, including motor vehicles, aircraft, stationary fuel combustion sources, and open-burning operations also contribute significant quantities of emissions within all four of Hawaii's counties. Thus, it would be desirable

to include the entire State in the Region. In this way all the existing and potential air pollutant sources would be subject to control provisions developed as part of the plan to implement air quality standards within the Region.

Air quality data was not sufficiently comprehensive to allow a determination of relative degrees of air purity among Oahu and the Neighbor Islands. On the basis of comparison with other metropolitan areas of similar size, Honolulu is at present one of the less polluted areas in the Nation. This is not to say that the potential for Honolulu City-County to become more seriously polluted is nonexistent, or that existing pollution levels are too low to warrant serious concern. In accordance with the provisions of the Clean Air Act, as amended, which call for the protection and enhancement of the air resources, it is logical to conclude that the entire State of Hawaii, including the relatively lightly populated Neighbor Islands, would benefit by designation as a region. Without the benefit of a region-wide control effort the projected expansion of population and pollutant producing activities, including power generation and manufacturing, will be more likely to lead to seriously affected air quality. This fact is more evident since study indicates that topographical and meteorological conditions in Hawaii are likely to lead to restricted pollutant dispersion potential much of the time

throughout the year. Thus, although Hawaii is free of serious pollution caused by transport from nearby areas, it is not free of the conditions leading to localized air pollution problems.

Projected population statistics indicate that Honolulu will continue to serve as the metropolitan area for the rural areas of Oahu and for the remaining three Counties in Hawaii. At present Oahu contains over 80% of the State's population on less than 10% of its total land area. The Neighbor Islands are expected to continue to gain in population at a modest rate due to the influence of tourism and new agricultural and industrial enterprises. These development trends are expected to perpetuate and strengthen the continuous mutual economic and social interdependence between Oahu and the Neighbor Islands.

Planning at the State level in Hawaii is dependent upon the close cooperation of planning programs at the County level. In addition, close cooperation between Counties exists in recognition of the fact that planning decisions affecting one part of the State are likely to affect, in some way, another part of the State. In this same way, it would be most logical to include the entire State in the Region for the purposes of air pollution control planning. This would make possible the utilization of existing cooperative ties among State and County governments and would allow the entire State to share in the

costs and benefits of a region-wide air pollution control effort.

In summary, the proposed Region is considered to be the most cohesive and inclusive area within which an effective regional air pollution control effort can be instituted. Official designation of the Region will follow the formal Consultation with appropriate State and local officials and after due consideration of comments presented for the record at the Consultation or of those written comments received by the Commissioner of the National Air Pollution Control Administration.